has not done or thought of doing—*prove* the proportionality of cause and effect. Neither he, nor any other of Mr. Spencer's opponents, has made the smallest attempt to deal with this main issue. Mr. Spencer alleges that this cognition of proportionality is *à priori:* not in the old sense, but in the sense that it grows out of experiences that precede reasoning. His opponents, following Prof. Tait in the assertion that Physics is a purely experimental science, containing, therefore, no *à priori* truths, affirm that this cognition is *à posteriori*—a product of conscious induction. Let us hear what are the experiments. It is required to establish the truth that there is proportionality between causes and effects, *by a process which nowhere assumes* that if one unit of force produces a certain unit of effect, two units of such force will produce two units of such effect. Until the "Senior Wrangler" has done this he has left Mr. Spencer's position untouched.

Bayswater, May 20 JAMES COLLIER

The Great Ice-Age

IN reply to Mr. Belt's letter (p. 62), I did little more than express an adverse opinion to his theory, because to discuss it would have required an essay. I expressed this because I notice that unless something like a demurrer is entered against a new theory it is apt to be taken for granted in subsequent text-books and papers written by those who have had no opportunities of obtaining a practical knowledge of the subject. For the above reason I must answer his strictures very briefly.

(1) I fail to see why the Scandinavian sea-beaches are irrelevant. (2) I have more than once read Mr. Tiddeman's paper, and without committing myself to all its conclusions, think I may quote it as assuming that the Lake district (as distinguished from North Lancashire) was the centre of a great ice-sheet; not that it was over-ridden by ice coming from somewhere further north. The same might be expected to be the case with the Welsh mountains; and Mr. W. Kingsley has brought forward good evidence of the existence of an ice-sheet there also. (3) Mr. Belt appears to forget that shells have been found not only at Moel Tryfaen, but also near Llyn Ffynnon-y-gwas, about two miles west of the peaks of Snowdon. Does Mr. Belt mean to say that Snowdon could not protect itself in the heart of its own domain better than this? If the Lake mountains had an ice-sheet, surely Snowdonia? Mr. Belt asks for evidence of the shore of the glacial sea. I reply that to me these and the Moel Tryfaen beds, not to mention others, appear to be far more probably littoral deposits than transported. For example, I think it in the highest degree improbable that the Vale Royal shells (Lyell, "Antiquity of Man," p. 317) could be brought to their present position (more than 1,100 feet above the sea) by any ice-sheet without the cold being enough to cover *all* the higher ground in Britain with ice, and so protect it. I did not deny a glacier might push a stone before it up-hill; my contention was that the enormous force which would be exerted on beds scooped out as described, and shoved some 1,500 feet up-hill for miles over broken ground, would crush the shells to a far more comminuted state than they are now in. With regard to Holderness, Mr. Croll's view of the shells there appears to me to be at present only a *theory* of which Mr. Searles V. Wood, jun., has effectually disposed (Geol. Mag. 1872). I grant there are some difficulties in the submergence theory; my position is that those in Mr. Belt's are very much greater.

A recent perusal of Mr. J. Geikie's suggestive book, the "Great Ice Age," has brought before my mind more strongly than ever a dilemma, which, as it appears to me, the modern school of Glacialists cannot escape.

He speaks of the till as a *grund moräne* or *moraine profonde* formed between the glacier and the rock, while he attributes the majority of rock-basins to the action of the glaciers. Now it appears to me that if the glaciers could pass over considerable deposits of this *moraine profonde* without sweeping it clean away, then their action as erosive agents must have been comparatively feeble; or, if they could scoop out great rock basins like the Alpine and (buried) Highland lakes, then they would have peeled off almost all the till from the land. As it appears to me, the analogy with a river, by means of which Mr. J. Geikie (p. 88) seeks to escape from a portion of this difficulty, does not hold. When a river begins to deposit sand and gravel largely, its work as an erosive agent at that place is almost over. Besides we cannot conceive a nearly solid mass, like a huge glacier, changing its motion so rapidly as a stream of water. Difficult as it undoubtedly is to explain some of the lake-basins, it appears to me that the great bulk of his evidence, with regard to till and other deposits over which ice-streams have passed, shows how slight under ordinary circumstances is their erosive power; and this has been confirmed by every journey that I have made among the Alps. I may add also that from study of the same regions my faith in a *moraine profonde* is much shaken. I believe that, except possibly as a very local and exceptional phenomenon, it exists solely in the imagination of the eminent geologists of whom Mr. Geikie is a disciple. T. G. BONNEY

St. John's College, Cambridge, May 26

Photographic Irradiation

IN the paper referred to by Prof. Forbes (NATURE, vol. x. p. 29) what is ordinarily called Photographic Irradiation was attempted to be explained by us, not as being caused by reflections from the back of the plate, but as being due to the sum of all the optical imperfections of the instrument with which the photograph is taken.

If Mr. Stillman (p. 63) will refer to our original paper, published in the *Monthly Notices* for June 1872, he will find that only the cloudy indefinite haze which surrounds the image of a luminous object, and which has frequently been called halation, was referred by us to reflection from the back of the plate.

When an over-exposed photograph is taken upon an opaque plate a marked fringe of irradiation still remains, and experiments were instituted by us which appeared to show that this is not to be accounted for by any circulation taking place within the thickness of the collodion or by the chromatic dispersion of the lenses; but when the oblique pencils from the edges of the lenses were stopped out the irradiation fringe was found to be greatly decreased. We were led to conclude that irradiation is to be accounted for by the fact that each luminous point in the object is not accurately represented by a luminous point in the image, but rather by a luminous patch of sensible area, the central and more intense portion of which prints itself first in the photograph, giving comparatively sharp picture prints when the exposure is short; but as the picture is still further exposed, the outer portions of the luminous patches imprint themselves, and by their overlapping cause the blurred appearance to which has been given the name of irradiation. LINDSAY

A. COWPER RANYARD

Uncompensated Chronometers and Photographic Irradiation

WITH regard to the employment of uncompensated chronometers (NATURE, vol. x. p. 63), I have every reason to believe that the Russians alone have tested them. For some reason which is not easily discovered, the employment of a negatively compensated chronometer has not given any very remarkable results. The Russians have employed simply an uncompensated chronometer; and have obtained very remarkable results as mentioned in my article on the Transit of Venus to which Prof. Everett has alluded.

With regard to the prevention of photographic irradiation, of course various means have been employed for dry plates; but I believe that Lord Lindsay and Mr. Ranyard were the first to experiment on the matter exhaustively. I believe Mr. Stillman would be interested in reading their paper in the *Monthly Notices*. At the same time all honour is due to the photographers named by him for their experiments.

Birkenhead, June 1 GEORGE FORBES

The Seal Fishery

CAPT. DAVID GRAY, of the steamship *Eclipse*, has done good service to the cause of humanity in writing, and Mr. Buckland in publishing, the letter on the seal fishery which appears in *Land and Water* for May 9. The fearful cruelties perpetrated year after year, and the enormous waste of life entailed by the reckless manner in which the seal fishery is prosecuted, are well known, but no steps have hitherto been taken to regulate a trade which, if carried on within proper bounds, would continue to yield great profits, but if still pursued with such utter disregard to consequences must soon end in the extermination of the whole race. As an instance of the wastefulness of the mode of proceeding, Capt. Gray says that five ships attacking a pack of seals, in four days killed about 10,000 old seals; "add 20 per cent. for seals mortally wounded and lost, gives an aggregate of 12,000 old ones; add 12,000 young which died of starvation, gives 24,000; but this is not all. The men spread on the ice, so that the old ones that were left alive could not get on to suckle their young. The consequence was that the whole of the young

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brood was destroyed, and had these seals been left alone for *eight or ten days*, I am quite within the mark when I say that, instead of only taking 300 tons of oil out of them, 1,500 could as easily have been got, and that without touching an old one." In one day by the men of the five ships upwards of 4,000 old seals were taken, "the young ones in thousands yelling for their mothers, following the skins as the men dragged them to the ships, and sucking the crangs, *i.e.* skins, in desperation." The maternal love for its offspring was made use of to save the men trouble, as a seal killed when giving suck was more easily secured, and often seals desperately wounded were seen administering nourishment to their young ones. The plight of the young ones which had lost their mothers was pitiful in the extreme; they were seen huddling together for heat, "and trying to suck one another," till they at length succumbed. Capt. Gray exclaims, "surely there is influence enough left in Great Britain to prevent a continuation of such barbarity. I overheard some of my men saying to one another, 'It is a shame this sort of work;' and so it is. It is a shame that any civilised Government should allow its subjects to perpetrate such cruelty when it could so easily be prevented. The remedy is simply, *let the ships be kept from sailing before March* 25; ships now sail from Feb. 25 to March 1. This would give a fortnight to make the passage, and find the seals in; by that time the young would be beginning to be worth taking, and a fearful waste of life put a stop to that now annually occurs." The accounts of the cruelties practiced in sealing are sickening in the extreme, the only thing considered being how to deprive as great a number of their skin and blubber in as short a time as possible. Mr. Brown (Proc. Zool. Soc., 1868) remarks: "Seals are very tenacious of life, and difficult to kill, unless by a bullet through the brain or heart. They are so quickly *flensed* (the operation of removing the blubber and skin) that after having been deprived of their skin they have been seen to strike out in the water; so that the sympathies of the rough hunters have been so excited that they will pierce the heart several times with their knives before throwing away the carcass." These movements Mr. Brown attributes to reflex action, but considering the haste of the operation, and the seal's known tenacity of life, it is quite as likely that it was merely a stunned and not a dead animal thus deprived of its skin and blubber. It is terrible to dwell thus upon the horrors of this cruel trade, which make even the hardened participators sicken and relent, but it is necessary that it should be done, in order, if possible, to reach the hearts of Englishmen, and enlist their sympathies. If these beautiful and harmless creatures must be sacrificed for our requirements, it is a duty incumbent upon us to see that their destruction is carried out mercifully, and with the infliction of as little suffering and waste of life as possible.

In a commercial point of view the reasons for exercising some supervision over the seal fishery are as strong as those dictated by mere humanity. The revenue produced by this branch of industry is considerable. Mr. Brown estimates the annual value of the Greenland fishery alone at 116,000*l.* (Proc. Zool. Soc., 1868, p. 439), and ominously adds: "Supposing the sealing prosecuted with the same vigour as at present, I have little hesitation in stating my opinion that, before thirty years shall have passed away, the 'seal fishery' as a source of commercial revenue will have come to a close, and the progeny of the immense number of seals now swimming about in the Greenland waters, will number comparatively few." We cannot plead want of warning, for we have numerous instances of marine animals which have been exterminated by untimely slaughter (See Prof. Newton's "Extermination of Marine Mammalia," NATURE, vol. ix. p. 112). Steller's Mantee survived its discovery only about twenty-seven years; the Atlantic Right Whale, which formerly gave employment to a great number of hardy fishermen in the Bay of Biscay and English Channel, is probably exterminated; the Northern Right Whales are gradually driven farther and farther north, and the risk of following them is becoming proportionately greater; the same may be said of the walrus. The northern fur-seal was rapidly passing away, and but for the timely intervention of the Russian and American Governments would probably have been lost; and from our antipodes comes an appeal repeating all the cruelties and waste of life to which our northern seals are subjected, and pleading for protection on behalf of the southern fur-seals (W. A. Scott, "Mammalia, Recent and Extinct," Sydney, 1873).

The question arises, how is this wanton destruction to be stopped and the fishery to be placed on a sounder footing? In order that it may be done effectually, the regulations must, without doubt, be "international;" and no time should be lost in carrying them into effect. The British Association has rendered good service in obtaining an Act to protect sea-birds during their breeding-time, and if, assisted by men of practical experience such as Capt. Gray, they were to urge upon the Government some course of action, they would be supported by all the scientific bodies and leading naturalists in the kingdom.

Norwich, May 12. THOS. SOUTHWELL

THE COMING TRANSIT OF VENUS *

VII.

IN our last article the preparations of Britain, Germany and Russia were enumerated; those of the French, Americans, Dutch, and Italians must now be spoken of.

V. The French will occupy the following stations:—Yokohama, Pekin, New Amsterdam or St. Paul's, and Campbell Island; all equipped as first-class stations, besides Tientsin, Sagou, Numea, and probably Nukahiva in the Marquesas, as secondary stations. Yokohama and St. Paul's will make an excellent combination for the method of durations; at Campbell Island also the durations will be considerably lessened. But the longitude of these places will be determined, so that if only one contact be observed, De l'Isle's method will be applied. MM. Wolf and André have made a series of experiments on the formation of the "black drop;" numerous trials have also been made with a view of employing the photographic method as successfully as possible, and it is possible that spectroscopic observations of external contact will be made. The preparations are by no means so far advanced as might have been wished. This is partly due to the disturbed state in which the country has been since the late war.

We are glad to be able to state that the French will employ the daguerreotype process of photography. This method has many advantages, and it is much to be regretted that no experiments have been made by other nations to test its applicability. Photographs taken by this process are well known to be much more delicate and give clearer details than any others, while photographic irradiation is reduced to a minimum. It is even possible to correct for curvature of field by employing prepared plates whose surfaces are portions of spheres, a thing which would be impossible by any other process. There can be no shrinking of the film. The only objection is, that we cannot print copies from the plates conveniently. But it is not likely that we should trust to measurements of a printed copy even from a glass negative. The French are relying mainly upon the photographic method, and have chosen their stations for determining thus directly the least distance between the centre of the sun and Venus. With the apparatus proposed by MM. Wolf and Martin, the size of the sun's image will be 60 millimetres; they hope to determine the instants of internal contact with a probable error of one second of time. The commission into whose hands the business has been entrusted has drawn up a detailed report containing contributions not only from the astronomers of France, but also from the most celebrated physicists and experimentalists: 300,000 fr. has been voted for the enterprise. M. Tisserand of the Toulouse Observatory will aid in the actual observations; and M. Jannsen will proceed to Yokohama.

M. Dumas takes the lead in the preparations. In a letter dated May 12, he says tha the expeditions are on the point of starting, and that the Marquesas probably, and Numea certainly, will be occupied for De l'Isle's method.

VI.—The Americans have a grant of 150,000 dols. They have paid great attention to the application of photography with the assistance of Mr. Rutherford, whose success in photographing the moon is so well known.

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* Continued from p. 69.

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